

CLAIMS

- 1 1. An apparatus comprising:
2 at least one processor;
3 a memory coupled to the at least one processor;
4 storage coupled to the at least one processor;
5 a virtual address space divided into a plurality of ranges;
6 a storage management mechanism residing in the memory and executed by the at
7 least one processor, the storage management mechanism assigning a corresponding task
8 group to each of the plurality of ranges, receiving an operation for the storage,
9 determining a range of virtual addresses affected by the operation, and delegating the
10 operation to a task group corresponding to one of the plurality of ranges that includes the
11 range of virtual addresses affected by the operation.
- 1 2. The apparatus of claim 1 wherein the storage management mechanism allows a
2 plurality of tasks within a task group to execute operations in parallel for operations that
3 do not conflict, and serializes execution of operations that do conflict.
- 1 3. The apparatus of claim 1 wherein each task group has a corresponding main queue
2 to which operations for the task group are sent and wherein each task within a task group
3 has a corresponding mini queue to which operations for the task are sent.
- 1 4. The apparatus of claim 3 wherein the storage management mechanism further
2 comprises a lock mechanism for assuring that only one task in a task group can access the
3 corresponding main queue at one time.

1 5. The apparatus of claim 1 wherein the storage management mechanism further
2 comprises a table that includes a plurality of entries, each entry specifying a task and a
3 range of virtual addresses of at least one operation being executed by the specified task.

1 6. The apparatus of claim 5 wherein the storage management mechanism further
2 comprises a lock mechanism for assuring that only one task in a task group can access the
3 table at one time.

1 7. An apparatus comprising:
2 at least one processor;
3 a memory coupled to the at least one processor;
4 storage coupled to the at least one processor;
5 a virtual address space divided into a plurality of ranges;
6 a storage management task executed by the at least one processor, the storage
7 management task assigning a corresponding task group to each of the plurality of ranges,
8 receiving an operation for the storage, determining a range of virtual addresses affected
9 by the operation, and delegating the operation to a task group corresponding to one of the
10 plurality of ranges that includes the range of virtual addresses affected by the operation,
11 each task group comprising:
12 a main queue to which operations for the task group are sent by the storage
13 management task and are received by at least one task in the task group;
14 for each task within a task group, a mini queue to which operations for the
15 task are sent;
16 a table that includes a plurality of entries, each entry specifying a task and
17 a range of virtual addresses of at least one operation being executed by the
18 specified task;
19 a first lock mechanism for assuring that only one task in a task group can
20 access the table at one time; and
21 a second lock mechanism for assuring that only one task in a task group
22 can access the main queue at one time.

1 8. A networked computer system comprising:
2 (A) a first computer system comprising:
3 primary storage; and
4 a virtual address space;
5 (B) a second computer system coupled to the first computer system, the second
6 computer system comprising:
7 mirrored storage;
8 the virtual address space of the first computer system divided into a
9 plurality of ranges;
10 a mirrored storage management mechanism that assigns a corresponding
11 task group to each of the plurality of ranges, receives an operation for the mirrored
12 storage from the first computer system, determines a range of virtual addresses
13 affected by the operation, and delegates the operation to a task group
14 corresponding to one of the plurality of ranges that includes the range of virtual
15 addresses affected by the operation.

1 9. A computer-implemented method for performing operations on storage in a
2 computer system, the method comprising the steps of:
3 dividing a virtual address space into a plurality of ranges;
4 assigning a corresponding task group to each of the plurality of ranges;
5 receiving an operation for the storage;
6 determining a range of virtual addresses affected by the operation; and
7 delegating the operation to a task group corresponding to one of the plurality of
8 ranges that includes the range of virtual addresses affected by the operation.

1 10. The method of claim 9 further comprising the steps of:
2 allowing a plurality of tasks within a task group to execute operations in parallel
3 for operations that do not conflict; and
4 serializing execution of operations that do conflict.

1 11. The method of claim 9 wherein each task group has a corresponding main queue,
2 and further comprising the step of sending operations for the task group to the
3 corresponding main queue.

1 12. The method of claim 11 further comprising the step of locking the main queue to
2 assure that only one task in a task group can access the main queue at one time.

1 13. The method of claim 9 wherein each task within a task group has a corresponding
2 mini queue, and further comprising the step of sending operations for the task to the mini
3 queue.

1 14. The method of claim 9 further comprising the step of writing a plurality of entries
2 to a table, each entry specifying a task and a range of virtual addresses of at least one
3 operation being executed by the specified task.

1 15. The method of claim 14 further comprising the step of locking the table to assure
2 that only one task in a task group can access the table at one time.

1 16. A computer-implemented method for performing operations on storage in a
2 computer system, the method comprising the steps of:
3 dividing a virtual address space into a plurality of ranges;
4 assigning a corresponding task group to each of the plurality of ranges, each task
5 group having a corresponding main queue and each task within a task group having a
6 corresponding mini queue;
7 receiving an operation for the storage;
8 determining a range of virtual addresses affected by the operation; and
9 delegating the operation by sending the operation to the main queue of a selected
10 task group corresponding to one of the plurality of ranges that includes the range of
11 virtual addresses affected by the operation.

1 17. The method of claim 16 further comprising the step of locking the main queue of
2 the selected task group to assure that only one task in the selected task group can access
3 the main queue at one time.

1 18. The method of claim 16 further comprising the step of sending operations for a
2 task to the corresponding mini queue.

1 19. The method of claim 16 further comprising the step of writing a plurality of
2 entries to a table, each entry specifying a task and a range of virtual addresses of at least
3 one operation being executed by the specified task.

1 20. The method of claim 19 further comprising the step of locking the table to assure
2 that only one task in a task group can access the table at one time.

1 21. A computer-implemented method for copying primary storage in a first computer
2 system to mirrored storage in a second computer system, the method comprising the steps
3 of:
4 writing data to the primary storage;
5 assigning a corresponding task group to each of a plurality of ranges in a virtual
6 memory space;
7 receiving an operation for the mirrored storage from the first computer system;
8 determining a range of virtual addresses affected by the operation; and
9 delegating the operation to a task group corresponding to one of the plurality of
10 ranges that includes the range of virtual addresses affected by the operation.

- 1 22. A program product comprising:
2 a storage management mechanism that assigns a corresponding task group to each
3 of a plurality of ranges in a virtual memory space, receives an operation for the storage,
4 determines a range of virtual addresses affected by the operation, and delegates the
5 operation to a task group corresponding to one of the plurality of ranges that includes the
6 range of virtual addresses affected by the operation; and
7 computer readable signal bearing media bearing the storage management
8 mechanism.
- 1 23. The program product of claim 22 wherein the signal bearing media comprises
2 recordable media.
- 1 24. The program product of claim 22 wherein the signal bearing media comprises
2 transmission media.
- 1 25. The program product of claim 22 wherein the storage management mechanism
2 allows a plurality of tasks within a task group to execute operations in parallel for
3 operations that do not conflict, and serializes execution of operations that do conflict.
- 1 26. The program product of claim 22 wherein each task group has a corresponding
2 main queue to which operations for the task group are sent and wherein each task within a
3 task group has a corresponding mini queue to which operations for the task are sent.
- 1 27. The program product of claim 26 wherein the storage management mechanism
2 further comprises a lock mechanism for assuring that only one task in a task group can
3 access the corresponding main queue at one time.

1 28. The program product of claim 22 wherein the storage management mechanism
2 further comprises a table that includes a plurality of entries, each entry specifying a task
3 and a range of virtual addresses of at least one operation being executed by the specified
4 task.

1 29. The program product of claim 28 wherein the storage management mechanism
2 further comprises a lock mechanism for assuring that only one task in a task group can
3 access the table at one time.

1 30. A program product comprising:
2 (A) a storage management mechanism that assigns a corresponding task group to
3 each of a plurality of ranges in a virtual address space, receives an operation for the
4 storage, determines a range of virtual addresses affected by the operation, and delegates
5 the operation to a task group corresponding to one of the plurality of ranges that includes
6 the range of virtual addresses affected by the operation, each task group comprising:
7 a main queue to which operations for the task group are sent by the storage
8 management task and are received by at least one task in the task group;
9 for each task within a task group, a mini queue to which operations for the
10 task are sent;
11 a table that includes a plurality of entries, each entry specifying a task and
12 a range of virtual addresses of at least one operation being executed by the
13 specified task;
14 a first lock mechanism for assuring that only one task in a task group can
15 access the table at one time; and
16 a second lock mechanism for assuring that only one task in a task group
17 can access the main queue at one time; and
18 (B) computer readable signal bearing media bearing the storage management
19 mechanism.

1 31. The program product of claim 30 wherein the signal bearing media comprises
2 recordable media.

1 32. The program product of claim 30 wherein the signal bearing media comprises
2 transmission media.

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